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ABSTRACT

The objective of this study was to compare data on preservice and inservice elementary teachers' attitudes toward science and science instruction. Four attitudes were assessed: (1) science as a male domain; (2) science usefulness; (3) confidence in teaching; and (4) effectance motivation (liking of science). These measures were selected since they have been shown to be related to sex differences with respect to science/mathematics enrollment and achievement. Attitude measures were administered to preservice teachers (N=48) during their senior year in college and to inservice teachers (N=77) in a southern Pennsylvania school district. Independent variables included levels of professional status (preservice/inservice), grade levels (preschool/2nd, 3rd/4th, 5th/6th, no preference), levels of instructional importance of science (high/low), sex (male/female), and levels of science courses taken in college (none, 1/2, 3 or more). Data were analyzed using multivariate analysis of variance, Duncan's multiple comparison test, and Tukey's HSD multiple comparison test. Significant differences were found for the main effects of professional status, science instructional ranking, and sex; and also for the interaction effects of professional status x college science, science ranking x sex, and science ranking x college science. Tables, references, implications, and recommendations for further research are included. (Author/JN)

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Elementary Teachers' Attitudes Toward Science in Four Areas Related to Gender Differences in Students' Science Performance

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Abstract

The primary objective of the study was to compare data on preservice and inservice elementary teachers' attitudes toward science and science instruction. Four attitudes were assessed. These were Science as a Male Domain, Science Usefulness, Confidence in Teaching Science, and Effectance Motivation in Science.

The attitude scales were administered to forty-eight (48) preservice elementary teachers during their senior year in college, and to seventy-seven (77) inservice elementary teachers in a Southern Pennsylvania school district.

The independent variables included two levels of professional status (preservice, inservice); four levels of grade (preschool-2nd, 3rd-4th, 5th-6th, no preference); two levels of instructional importance of science (high, low); two levels of sex (male, female); and three levels of science courses taken in college (none, 1-2, 3 or more).

The data was analyzed using Multivariate Analysis of Variance, Duncan's Multiple Comparison Test, and Tukey's HSD Multiple Comparison Test. Significant differences were found for the main effects of professional status, science instructional ranking, and sex; and the interaction effects of professional status x college science, science ranking x sex, and science ranking x college science.

Tables, references, implications and recommendations for futhre research are included.

Elementary Teachers' Attitudes Toward Science
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Objectives:

The primary objective of the study was to compare data on preservice and inservice elementary teachers' attitudes toward science and science instruction.

Four attitudes were assessed. These attitudes were delineated as, Science as a Male Domain, Science Usefulness, Confidence in Teaching Science and Effectance Motivation in Science. The attitude scales were chosen as they have been shown to be related to gender differences with respect to science/mathematics enrollment and achievement (Armstrong, 1980; Fennema and Sherman, 1977, 1978; Lantz, 1980; Levin and Fowler, 1982).

Theoretical Framework:

Much emphasis has recently been placed on the role of women in American society. Science educators have demonstrated increased awareness by spending more time and effort in the documentation and understanding of the sexual differences with respect to educational achievement, course selection, and career choices within the scientific fields.

Investigations of achievement show that females graduate with higher grade averages than males, but males out perform females on various assessments in mathematics and science (Golladay, 1977; Grant and Lind, 1979; National Science Foundation, 1980).

Similar data were also found when examining enrollment. When mathematics and scier e courses become optional in high school, far fewer females than males choose them (Haven, 1972; Sells, 1978). Fewer females than males aspire to major in science/engineering fields in college (Grant and Lind, 1979) as well.

Both past achievement and course selection must necessarily play an important role in career decisions and the development of attitudes. Data indicated that a relatively small proportion of all U.S. scientists and engineers are women (Vetter, 1978). Women make up approximately 40% of all persons in professional and technical occupations, but only 9% of the active science/engineering labor force (National Science Foundation, 1979).

The surveyed literature offered two possible causes for the sexual discrepancies in Science and Mathematics. The two positions were innate biological differences resulting in differing intellectual abilities between males and females and differential cultural stereotypical influences on what is desirable and expected behavior of males as opposed to females.

Sherman (1977) critically reviewed and examined the evidence for the biological hypothesis and concluded that, in most cases, the evidence was weak or non-existent. Thus, the hypothesis that sexual differences in achievement were linked to biological differences was not supported.

In contrast, the hypothesis that differential cultural influences contributed to the sexual differences has received much support. Gallagher (1975) stated, "It is a slight exaggeration to say that boys and girls grow up in markedly different worlds where different social

roles and different life patterns are imposed from without, by both family and culture." (p. 49) He believed that different sex roles began at an early age. Stein and Bailey (1973) felt that the sex roles were "well ingrained by adolescence." (p. 347)

Both parents and teachers exert much influence on students at all ages. One of the findings of the American Association for the Advancement of Science study on The Participation of Women in Scientific Research was that female scientists indicated that elementary and high school girls and boys interested in science were treated differently by parents, teachers, and friends. Girls received ambivalence, lack of encouragement, and messages that what they were doing was inappropriate, impractical, or unacceptable (National Science Foundation, 1978).

It has often been reported that the attitude of the teacher toward science does affect the attitude and performance of students (Behnke, 1959; Christiansen, 1974; Greenblatt, 1962; Mitchell, 1972; Yeoh, 1973). In assessing the previous experiences and/or individuals that influenced preservice elementary teachers' attitudes toward science, the teacher was the most important single influence stated, with one-fourth of the respondents explicitly describing experiences or individuals from their elementary and junior high school years (Westerback, 1982). Vannan (1971) claimed that science experiences at the elementary level had a lasting impression. After reviewing the literature, Ramsey and Howe (1969a, 1969b, 1969c) concluded that the role of the teacher in shaping pupils' attitudes and aptitudes was paramount.

Historically, approximately 85% of elementary teachers were women. Many of these teachers have lacked preparation in the sciences and were also products of the cultural influences that have operated against women with respect to sciences study. Thus, it is not surprising to find that only 22% of all elementary teachers felt "very well qualified to teach science." (National Science Foundation, 1980, p. 8) As a result, less time is spent teaching science in elementary schools than any other area of the elementary curriculum (National Science Foundation, 1980).

Inadequate science background was commonly given as a reason for teachers' reluctance to teach science (Victor, 1961; Blosser and Howe, 1969), and negative attitudes toward science and teaching science are commonplace among elementary teachers (Westerback, 1982). Some of the consequences of teachers' negative attitudes were the reluctance or avoidance of teaching science (Kennedy, 1973; Perkes, 1975) and the passing of negative attitudes on to students (Stollberg, 1969). Further evidence was found that students, especially females, perceived negative attitudes from elementary female teachers who were uneasy and anxious about teaching science and/or mathematics (Soy, 1967; Victor, 1961).

Evidence that negative attitudes toward science instruction in elementary teachers may be a continuous problem was supported by Norland and DeVito (1974). These findings indicated that freshman elementary education majors at Purdue University had a strong negative attitude toward science, and exposure to college-level science courses reinforced this negative attitude.

The present study addressed both inservice and preservice teachers' attitudes toward science in four relevant areas. The first attitude was Science as a Male Domain. The male domain scale assessed the degree to which teachers saw the study of science as a male, neutral, or female endeavor. Attitudes concerning science as a male domain could be a cause of the differential cultural messages that students perceive. Ernest (1976) reported that many elementary teachers thought of science as a male domain, and they were reluctant to teach it because of their unfamiliarity with the subject.

The second attitude was the Usefulness of Science. Usefulness assessed teachers' beliefs about the usefulness of science to their students' future. The usefulness of science scale was particularly important because students' perceived usefulness of a subject has been correlated with their decisions to study and enroll in a subject area (Armstrong, 1980; Lantz, 1980).

The remaining two scales were the Confidence in Teaching Science and Effectance Motivation of Science Scales, which can be defined as the liking of science (Armstrong, 1980). Both scales (e.g., Confidence, Effectance) were seen as important influences on teachers' attitude toward science instruction and teachers' influence on students.

Methods:

The four attitude scales were adapted from the Levin Science Attitude Scales (Levin and Fowler, 1982) to be pertinent to inservice and preservice teachers. The scales consisted of twelve items, six positive and six negative items per scale. There were five response alternatives. The alternatives were strongly agree, agree, undecided, disagree, and strongly disagree. Each response was given a score from 1-5 with the weight 5 corresponding to the response that was indicative of a positive attitude toward science instruction. A teacher's total score on each attitude scale was the cumulative total of each item score. The higher the score, the more positive the attitude.

The Science as a Male Domain Scale was interpreted somewhat differently. The less a teacher stereotyped science, the higher the score. The inversion of scores was implemented to reflect that the less a teacher stereotyped science, the more apt the teacher would be to communicate an unbiased attitude to the students.

Data Source:

The attitude scales were administered to forty-eight (48) preservice elementary teachers during their senior year in college. The data were collected in the final seminar meeting of an initial field experience required for all elementary education majors. The scales were also administered to seventy-seven (77) inservice elementary teachers in a Southern Pennsylvania school district during faculty meetings in their respective schools.

The attitude scales represented the four dependent variables (Male Domain, Usefulness, Confidence, Effectance Motivation). The independent variables included two levels of professional status (preservice, inservice); four levels of grade (preschool-2nd, 3rd-4th, 5th-6th, no preference); two levels indicating the instructional importance of science or science ranking (high, low); two levels of sex (male, female), and three levels of college science courses (none, one-two, three or more).

Alpha reliabilities of the four attitude scales ranged from .85 to .90 for both preservice and inservice teachers.

Analysis and Results:

The data were analyzed as an interaction model. Each individual's score on any dependent variable was seen to be represented by a linear combination of five main effects (status, grade, science ranking, sex, college science), and ten two-way interactions which represented the combinations of the main effects.

The Statistical Analysis System (SAS) was used to analyze the data (Statistical Analysis System, 1979). Due to the unbalanced nature of the sample cell sizes, the General Linear Model Procedure (GLM) of Multivariate Analysis of Variance (MANOVA) was used to test for significant main and interaction effects at the .05 level. Duncan's Multiple Comparison Test and Tukey's HSD Multiple Comparison Test were used for mean separation procedures.

There were significant differences found for the main effects of professional status, science instruction ranking, and sex; and the interaction effects of professional status x college science,[1] science ranking x sex, and science ranking x college science.

Table 1

Table 2 shows the results of Duncan's follow-up procedure for the main effects of status, science ranking, and sex. Preservice teachers had a significantly more positive attitude toward Confidence in Teaching Science than did the inservice teachers.

Table 2

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[1] Even though the MANOVA indicated a significant professional status x college science interaction, the follow-up procedure of Tukey's HSD indicated no significant difference (Table 5).

Teachers who ranked science instruction as a high priority had significantly more positive attitudes toward the Usefulness of Science, Confidence in Teaching Science, and Effectance Motivation (the liking of science). Males had a significantly more positive attitude in Confidence in Teaching Science.

Table 3 and Table 4 show the results of Tukey's HSD Multiple Comparison Follow-up for the interaction effects of science ranking x sex and science ranking x college science. Females who ranked science as a low instructional priority had the least positive attitude toward Confidence in Teaching Science and Effectance Motivation (liking) and were significantly different from the other three subsets of teachers on these attitude scales.

Table 3

Teachers ranking science instruction as a high priority with three or more college science courses had the most positive attitude toward Confidence in Teaching Science and were significantly different from teachers who ranked science low with two or less college science courses.

Table 4

Discussion, Implications, Future Research:

Significant differences between preservice and inservice (professional status) teachers were found (Table 2). Preservice teachers indicated significantly more positive attitudes toward Confidence in Teaching Science than did the inservice teachers. In addition, preservice teachers scored higher on all scales except Science as a Male Domain. Results of Norland and DeVito (1974) indicated that freshman elementary education majors had strong negative attitudes toward science, which were reinforced as they were exposed to college-level science courses. However, the present study revealed positive attitudes toward science and science instruction of senior preservice elementary teachers. This may be a result of the importance placed upon science by the media and/or the type of courses and instruction they received in science and science methods at the university level. The positive attitudes may also be accounted for by the number of science courses taken during their teacher training program. Fifty-six per cent (56%) of the preservice teachers had three or more college science courses as compared to only twenty-one per cent (21%) of the inservice teachers. This explanation seems to be consistent with the findings of Levin and Fowler (1982) that suggested that, at the high school level, students' attitudes varied directly with the number of science courses they had taken.

The present findings that only twenty-one per cent (21%) of the inservice teachers had three or more college-level science courses, and they had significantly less Confidence in Teaching Science, support the

results of the National Science Foundation (1980), which found that elementary school teachers did not feel qualified to teach science. Similarly, the present findings support the notion that inadequate science background may be the cause of the unqualified feeling on the part of the teachers (Blosser and Howe, 1969; Victor, 1961).

Whether attitudes toward science and science instruction change from preservice to inservice could not be assessed from this study. Perhaps, as teachers become further removed from new experiences in science and lose contact with new developments in both science and science education, they lose confidence in teaching science.

Significant differences in attitudes were found with respect to the ranking of science as an instructional priority (Table 2). Teachers who ranked science high as an instructional priority had significantly more positive attitudes in the Usefulness of Science, Confidence in Teaching Science, and Effectance Motivation. In addition, the interaction effect of science ranking by college science courses indicated that teachers who ranked science high and had three or more college science courses had a significantly more positive attitude on the Confidence in Teaching Science scale (Table 4). Thus, it seemed that the number of college science courses had an impact on teachers' attitudes. Support for this also comes from the present study that showed that forty-nine per cent (49%) of the teachers who had three or more science courses ranked science as a high instructional priority. The same figures for teachers with one or two courses and zero courses were thirty-one per cent (31%) and twenty-six per cent (26%), respectively.

The main effect of sex showed that males had a significantly more positive attitude toward Confidence in Teaching Science than did females. This finding supported results of studies by the National Science Foundation (1980), Soy (1967), and Victor (1961). Although not significant, males also scored higher on the Usefulness and Effectance Motivation scales, while females scored higher on Science as a Male Domain. Thus, both male and female teachers recognized the usefulness of science for their students, did not stereotype science as a male domain, and somewhat "like" science, but females felt less confident in teaching science.

Although not significant, it was noted that teachers in the preschool to grade 2 group scored highest on all scales, while teachers in the grade 5 to grade 6 group scored lowest. It was hypothesized that this may be a result of the difference in the emphasis placed on science between the early and upper elementary grades. In the early elementary grades, there is more of an emphasis on discovery, experiential learning, while content orientation becomes more prevalent in the upper grades. This lends support to the findings of Blosser and Howe (1969) and Victor (1961), which indicated that inadequate science background affects the teaching of science.

As the role of the teacher in shaping pupils' attitudes and aptitudes has been shown to be paramount (Ramsey and Howe, 1969a, 1969b, 1969c), the need to influence teachers' attitudes is evident.

The present study seemed to show that experiences in college science courses are influential on teachers' attitudes toward science and science teaching. Based on these results, several recommendations are made.

First, opportunities for positive experiences in the sciences should be provided for all preservice teachers. In addition, compensatory science experiences to promote positive attitudes toward science should be designed for preservice teachers.

Second, on-going inservice education programs, stressing experiential approaches, as well as content orientations, are recommended.

Third, for content-oriented courses in upper elementary grades, explicit content outlines should be provided to teachers. This explicit outline would include methods to facilitate content instruction.

Fourth, both inservice and preservice teachers should be educated on the importance of modeling positive attitudes in the science classroom, as well as in the use of methods that facilitate positive students' attitudes toward science.

Directions for future research include:

a. Longitudinal studies that monitor changes in teachers' attitudes toward science throughout their college and inservice teaching careers.

b. Longitudinal studies that attempt to assess the influential factors that affect changes in teachers' attitudes toward science.

c. Design and evaluation of inservice programs and their effects on teachers' attitudes toward science.

d. Multiple correlation studies of teachers' attitudes toward science and students' attitudes and achievement in science.

Table 1

Results of the 2x4x2x2x3 MANOVA

Source		SSCP Useful	Conf.	Male	Motivate	df	F^1	p
Status	Useful	79.65						
	Confidence	206.31	534.41			1	4.09 (4, 92)	.004<.05*
	Male Domain	-64.89	-168.08	52.86				
	Motivation	60.29	156.18	-49.12	45.64			
Grade	Useful	96.67						
	Confidence	135.98	202.14					
	Male Domain	65.46	106.33	72.55		3	0.61 (12, 243)	.834>.05
	Motivation	159.84	234.32	137.87	303.52			
Science Ranking	Useful	167.54						
	Confidence	393.95	926.29					
	Male Domain	-13.08	-30.75	1.02		1	4.99 (4, 92)	.001<.05*
	Motivation	473.91	1114.30	-36.99	1340.47			
Sex	Useful	168.79						
	Confidence	340.69	687.61					
	Male Domain	25.29	51.06	3.79		1	2.77 (4, 92)	.031<.05*
	Motivation	317.55	640.91	47.59	597.37			
College Science	Useful	12.67						
	Confidence	-10.54	112.89					
	Male Domain	-9.32	54.17	27.55		2	0.58 (8, 184)	.797>.05
	Motivation	-5.60	1.03	2.50	2.61			
Status x Grade	Useful	158.40						
	Confidence	58.67	153.88					
	Male Domain	-6.70	-11.21	0.86		2	1.10 (8, 184)	.364>.05
	Motivation	133.83	118.04	-10.18	148.55			

Table 1 (cont'd)

Results of the 2x4x2x2x3 MANOVA

Source		Useful	SSCP Conf.	SSCP Male	SSCP Motivate	df	F[1]	P
Status x Science Ranking	Useful	0.29				1	0.82 (4, 92)	.516 > .05
	Confidence	7.09	170.99					
	Male Domain	2.00	48.23	13.60				
	Motivation	6.75	162.72	45.89	154.85			
Status x Sex	Useful	3.29				1	0.20 (4, 92)	.938 > .05
	Confidence	4.59	6.41					
	Male Domain	7.23	10.09	15.89				
	Motivation	7.72	10.78	16.97	18.12			
Status x College Science	Useful	282.72				2	2.03 (8, 184)	.045 < .05*
	Confidence	199.02	243.72					
	Male Domain	237.19	209.91	216.78				
	Motivation	262.66	314.17	273.93	405.29			
Grade X Science Ranking	Useful	11.95				2	0.50 (8, 184)	.852 > .05
	Confidence	30.23	96.56					
	Male Domain	17.79	15.59	69.59				
	Motivation	17.09	59.42	1.77	37.47			
Grade x Sex	Useful	39.92				3	0.55 (12, 243)	.881 > .05
	Confidence	-11.79	51.89					
	Male Domain	22.13	22.22	90.94				
	Motivation	12.91	2.73	-11.61	13.39			
Grade x College Science	Useful	84.07				5	0.68 (20, 306)	.848 > .05
	Confidence	39.53	120.59					
	Male Domain	-8.45	10.31	33.59				
	Motivation	1.19	181.33	-32.31	434.49			

Table 1 (cont'd)

Results of the 2x4x2x2x3 MANOVA

Source		Useful	Conf.	SSCP Male	Motivate	df	F[1]	P
Science Ranking x Sex	Useful	244.91				1	2.83 (4, 92)	.029<.05*
	Confidence	-21.06	1.81					
	Male Domain	-12.24	1.05	0.61				
	Motivation	89.32	-7.68	-4.47	32.57			
Science Ranking x College Science	Useful	132.07				2	2.28 (8, 184)	.023<.05*
	Confidence	121.60	557.56					
	Male Domain	47.88	351.57	229.54				
	Motivation	102.78	412.79	256.81	307.15			
Sex x College Science	Useful	6.09				2	0.97 (8, 184)	.463>.05
	Confidence	5.38	94.73					
	Male Domain	12.10	-83.86	123.46				
	Motivation	6.27	45.13	-29.13	29.13			
Error	Useful	2873.65				95		
	Confidence	2048.92	7444.59					
	Male Domain	919.15	1232.74	2407.22				
	Motivation	1969.13	5105.02	773.19	6973.26			
Total/ Adjusted for the Mean	Useful	4362.69				124		
	Confidence	3548.57	11406.11					
	Male Domain	1241.54	1819.37	3359.87				
	Motivation	3615.64	8551.15	1382.71	10838.67			

[1] Using Wilk's Criterion
* P<.05

Table 2

Duncan's Mean Differences on Attitude Scales

Attitude Subscales	Status		Science Ranking		Sex	
	Preservice (N=48)	Inservice (N=77)	High (N=45)	Low (N=80)	Male (N=22)	Female (N=103)
Useful	48.88	47.23	49.49	46.95	49.46	47.52
Confidence	45.77	41.52	47.16	40.90	46.64	42.41
Male Domain	53.21	54.55	53.67	54.24	53.50	54.15
Motivation	43.33	42.09	46.67	40.26	45.55	41.93

Note: Means connected by the same line denote nonsignificant differences at the .05 level.

Table 3

Tukey's HSD Means Comparisons of Attitude Scales
Science Ranking x Sex

Useful	(L, M) 50.92	(H, F) 50.00	(H, M) 47.70	(L, F) 46.25
Confidence	(H, M) 50.10	(H, F) 46.31	(L, M) 43.75	(L, F) 40.39
Male Domain	(L, M) 54.50	(L, F) 54.19	(H, F) 54.06	(H, M) 52.30
Motivation	(H, M) 47.60	(H, F) 46.40	(L, M) 43.83	(L, F) 39.63

Note: Means connected by the same line denote nonsignificant difference at the .05 level.

Science Ranking
H = High, ranked 1, 2, 3 in importance
L = Low, ranked 4, 5 in importance

Sex
M = Male
F = Female

Table 4

Tukey's HSD Means Comparisons of Attitude Scales
Science Ranking x College Science

Useful	(H, 1) 50.00	(H, 2) 49.89	(H, 3) 49.00	(L, 3) 48.13	(L, 1) 47.00	(L, 2) 46.29
Confidence	(H, 3) 50.67	(H, 2) 44.22	(H, 1) 43.67	(L, 3) 42.14	(L, 2) 40.56	(L, 1) 40.12
Male Domain	(H, 3) 55.62	(L, 1) 54.82	(L, 2) 54.63	(L, 3) 53.05	(H, 2) 52.06	(H, 1) 51.67
Motivation	(H, 3) 47.90	(H, 2) 45.67	(H, 1) 45.33	(L, 2) 40.63	(L, 3) 40.23	(L, 1) 39.41

Note: Means connected by the same line denote nonsignificant differences at the .05 level.

Science Ranking
H = High, ranked 1, 2, 3 in importance
L = Low, ranked 4, 5 in importance

College Science
1 = No college science courses
2 = One or two college science courses
3 = Three or more college science courses

Table 5

Tukey's HSD Means Comparisons of Attitude Scales
Status x College Science

Useful	(P, 1) 52.00	(P, 3) 49.85	(I, 2) 47.71	(I, 1) 46.89	(P, 2) 46.58	(I, 3) 46.37
Confidence	(P, 3) 47.93	(I, 3) 43.56	(P, 1) 43.25	(P, 2) 42.94	(I, 2) 41.17	(I, 1) 40.58
Male Domain	(I, 2) 55.14	(P, 3) 54.74	(I, 1) 54.05	(P, 1) 53.75	(I, 3) 53.56	(P, 2) 50.65
Motivation	(P, 3) 45.00	(I, 2) 42.55	(I, 3) 42.25	(P, 2) 41.24	(P, 1) 41.00	(I, 1) 40.95

Note: Means connected by the same line denote nonsignificant differences at the .05 level.

Status
P = Preservice
I = Inservice

College Science
1 = No college science courses
2 = One or two college science courses
3 = Three or more college science courses

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